THE STATUS OF THREE TUNDRA WINTERING CARIBOU HERDS IN NORTHEASTERN MAINLAND NORTHWEST TERRITORIES

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THE STATUS OF THREE TUNDRA WINTERING CARIBOU HERDS IN NORTHEASTERN MAINLAND NORTHWEST TERRITORIES

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ABSTRACT

We determined the distribution, population size and calf production of three herds of barren-ground caribou (Rangifer tarandus groenlandicus) which range year-round on the mainland tundra of northeastern Northwest Territories. Population estimates were based on aerial transect surveys flown over a 170,000 km^2 area in June 1976. Data on population structure and distribution were collected during the summers of 1976 and 1977. Separate calving grounds and distinct summer ranges were the criteria used to define the three herds. The Lorillard herd, occupying the region between Chesterfield Inlet and Wager Bay, contained about 17,000 animals over 1 year of age. The Wager herd, ranging north of Wager Bay, was the smallest with only 12,000 caribou. The Melville Peninsula herd was estimated at 52,000 based on a calving ground population of 28,000. These results indicate that substantially more caribou inhabit northeastern Northwest Territories than was previously thought. In August, calves averaged over 20% of the total population and yearlings comprised about 16% of the caribou over 1 year of age. Because calf and yearling survival is so high and few animals are killed by hunters, these herds are probably increasing.

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1. INTRODUCTION

Barren-ground caribou (Rangifer tarandus groenlandicus (Linnaeus)) range over most of the 2,000,000 km^2 of mainland Northwest Territories. In this area, which is about half forest and half tundra (Fig. 1), four major herds are recognized. These herds, the Bluenose, the Bathurst, the Beverly and the Kaminuriak migrate between winter ranges within the boreal forest to calving areas and summer ranges on the tundra, sometimes 800 km away (Fig. 1).

The only area of mainland Northwest Territories not included in the ranges of these herds is the northeast (Fig. 1). Caribou were known in this area but information on them was limited to explorers' observations (Manning 1943), reports of native hunters and three aerial surveys. Although handicapped by poor weather and navigational difficulties, those surveys indicated calving areas on southern Melville Peninsula and north of Wager Bay, and a population of less than 4,000 caribou. The objective of our study was to obtain more precise data on population size, distribution and status of these caribou.

In accordance with geographical features and existing knowledge of caribou distribution, we divided the study area into three units which we thought might contain discrete populations of caribou. The first unit of 65,000 km^2 encompassed the drainage of the Lorillard River system, and all the area between Wager Bay and Chesterfield Inlet (Fig. 2). We named the caribou here, the Lorillard herd. The second unit, containing the Wager herd (Fig. 2) included the 57,000 km^2 to the north of Wager Bay. The third region encompassed 48,000 km^2 of southern Melville Peninsula. Here we expected to find the Melville herd.

The southwestern coast of Melville Peninsula and the south shore of Wager Bay are steep, rocky and barren, rising sharply as much as 600 m above sea level (asl). The north shore of Wager Bay is also high and rugged, but a coastal plain about 16 km wide, separates the mountains from the bay. Most of the study area is undulating with abundant rock out-crops and boulder-strewn vegetated areas. Relatively well drained grass-heath communities predominate over soggy sedge meadows.

2. METHODS

Population estimates were based on the number of caribou counted on aerial line transects. In the Lorillard region, 21 north-south transect lines 16 km apart were surveyed between 15 and 25 June 1976. On 29 June, a reconnaissance flight was made to determine the general caribou density and distribution north of Wager Bay. On the basis of this information, we divided the area into four strata (Fig. 3). Stratum 1 with the lowest caribou density received 5% coverage from seven transects each 32 km apart. Seven transect lines established over stratum 2, and eight over stratum 3, gave about 10% and 15% coverage respectively. In Stratum 4, because of rugged topography and the dense aggregations of caribou, we attempted to count all animals. The surveys were completed by 2 July.

The caribou distribution on Melville Peninsula was determined during a reconnaissance flight on 19 June 1976. Thirty-three transect lines were established over an area within which only cows and calves were found. Lines spaced at 4.0 km intervals over most of the area resulted in 20% coverage. Low density areas on the periphery of the calving ground received only 5% or 10% coverage. The Melville Peninsula survey required 27 flying hours over 3 days, 19 - 21 June 1976. Although this amount of flying caused some fatigue to the observers, it was necessary to minimize the chances of caribou moving or of bad weather interrupting the survey.

Transects were flown at an altitude of 120 m at 190 km/hr in a Cessna 185 or Cessna 337 aircraft. One observer on each side of the aircraft counted all caribou within 0.8 km (Lorillard and Wager herds) or 0.4 km (Melville herd) of his side and classified them as cows, calves, bulls, or unknowns. Calves were easily recognizable by their small size and reddish colour, and bulls were distinguished by the presence of antlers. All non-bull caribou in groups containing calves were considered to be cows. The pilot navigated and plotted the location of each sighting on 1:250,000 scale topographical maps while observers recorded corresponding data on tape recorders, thus never having to look away from the transect strip. One survey team surveyed Melville Peninsula and another surveyed the Lorillard and Wager herds.

Population estimates and variances were calculated using Jolly's Method 2 for unequal sized sampling units (Jolly 1969) and Norton-Griffiths' method for integrating the results from different strata (Norton-Griffiths 1975). These calculations were based on statistical theory requiring transects to be spaced randomly (Jolly 1969, Norton-Griffiths 1975). However, we used an even, rather than random spacing of transects in these surveys for three reasons. Evenly spaced transects simplify navigation and provide a more accurate evaluation of animal distribution while still giving an unbiased population estimate for which the estimate of variance is not greatly affected (Cochran 1977, Caughley 1977, Pennycuick et al. 1977). So long as systematic samples do not correspond to a periodic clumping of animals, "the axioms of the statistical model [based on random sampling] are not grossly violated." (Caughley 1977).

Throughout this paper, precision is expressed as the half width of the 95% confidence interval on the population estimate as a per cent of this estimate. Population estimates were increased 25% to account for animals within the transect but overlooked by observers. This 25% correction factor is based upon tradition (e.g. Parker 1972), but a recent empirical study produced a similar estimate of bias, 29% (Fischer and Duncan 1976).

Data on caribou distribution and population structure were also obtained in August 1976 on the Wager herd and on all herds during the summer of 1977 (4 June to 3 September). Aerial surveys provided most information, but observations were also made from the ground on the Wager herd, 25 July to 7 August and 26 August to 2 September 1977, and the Melville herd, 22 - 25 August 1977. Ground observations were necessary to determine the proportion of yearlings in these herds. Only mature bulls and calves can be distinguished from the air, but on the ground we could recognize yearling males, yearling females, calves, mature bulls, young bulls and adult females.

3. RESULTS

3.1 Lorillard Herd

Caribou were observed over the entire 64,000 km^2 surveyed (Fig. 2). By multiplying the caribou density as determined from aerial transects by the size of the study area, and then correcting for observer bias, the population size of the Lorillard herd was estimated at 17,225 (Table 1). As a result of the high variance in the number of caribou observed per transect, 95% confidence limits were high, 50.8% (Table 1).

The calving ground of this herd was a 12,000 km^2 area of highlands 250 m to 500 m asl at the headwaters of the Lorillard River, just south of Wager Bay (Fig. 4). The rest of the census zone was generally below 150 m asl. Eighty-eight per cent (326/370) of the calves were found on this calving ground (Table 2). Most (81%, 588/723) bulls and unknowns (yearlings and nonproductive cows) occupied the other areas, primarily along the Lorillard River and toward the Hudson Bay coast (Table 2, Fig. 4).

A second estimate of the size of the Lorillard herd can be made by extrapolating the data from the calving ground. The number of caribou over 1 year of age on the calving ground was 8,538 (Table 1). If the Lorillard herd is dispersed in the same way as other herds, specifically the Kaminuriak herd in southeastern Northwest Territories, then 80% of the non-calf caribou on the calving grounds should be breeding females and should comprise 43% of the population (Parker 1972).

Adult females did make up 80% of the non-calf animals on the calving grounds (Table 2). If these females made up 43% of the herd, then the Lorillard population would be 15,884 animals (8,538 X 0.80 ÷ 0.43). This is very close to the previous estimate of 17,225 and suggests that our estimate of herd size is more precise than the broad confidence interval indicates.

Caribou density (excluding calves) was over four times higher on the calving ground than elsewhere (0.56/km^2 vs. 0.13/km^2). Group size on the calving ground ranged between 1 and 100 with a mean (including an average of 3.8 calves per group) of 7.9 ± 1.3. The calf to cow ratio based on data from the whole study area was 60 calves to 100 cows (370:621). Calves in June made up 21% of the herd in 1976 and 30% in 1977 (Table 3).

3.2 Wager Herd

Caribou were not observed over the entire 57,000 km^2 area surveyed. None were seen north of 67°08' N. although we flew transects all the way to the tip of Simpson Peninsula (69°18' N., Fig. 2).

Our results indicate that the Wager herd was dispersed over 37,500 km^2 and numbered about 12,000 caribou over 1 year of age. About half of this herd was found in stratum 2 (Table 4, Fig. 3). Ninety-five percent confidence limits on the population estimate were 23.6%.

When complete counts are undertaken, the sampling error is zero. However, there may still be some error in the form of observer bias. It is possible that in stratum 4 the numbers of caribou in the large groups were estimated incorrectly, and some groups were missed while others were counted more than once. A check on these potential biases can be obtained since we attempted to count all the animals in stratum 4 on our reconnaissance flight. We counted 1,381 caribou over 1 year of age on the reconnaissance flight and 1,185 during the actual survey. The close similarity between these two results (Table 4) was encouraging. It would have been unreasonable to expect identical results because caribou could have moved in or out of the area in the 2 days between these surveys, and the boundaries, although similar, were not identical on both days. The similarities between counts suggested that little bias resulted from over-counting or missing large numbers of caribou. However, assuming consistency between days, biases in the estimation of group size would not show up in this comparison.

The majority of the Wager herd calved in a 5,000 km^2 area of highlands (300-450 m asl) north of the west end of Wager Bay near Curtis Lake (Fig. 3 and 4). Ninety-five percent of calves observed in June 1977 were in those hills. In 1976 some post-calving groups had left the calving ground by the time of the survey, 29 June to 2 July. The largest group had moved south to the Wager Bay coast (stratum 4, Fig. 3).

The highest density of calves occurred in stratum 4, but the number estimated to be in each stratum was quite similar (Table 5). As in the Lorillard herd, bulls were not common on the calving ground. Ninety-five percent of bulls observed were within 16 km of the coast (Fig. 4).

The density of adult caribou increased with sampling intensity (strata 1 through 4) as predicted from the preliminary survey (Table 4). The average group size (including calves) in strata 1, 2 and 3 combined was 7.8 ± 1.4 (Table 6). The density was so high in stratum 4 that although clumping did occur, it was impossible to distinguish individual groups.

The calf to cow ratio was 58 calves to 100 cows (Table 7). In compiling the data for Table 7, two groups in which the calf count was only estimated were omitted from strata 2 and 3. In stratum 4 we concentrated on obtaining accurate counts of adults, thus the number of calves counted was low. In most groups, adults were enumerated and calves estimated. If data from only strata 1, 2 and 3 are used to calculate the calf-cow ratio, the result is 60 calves:100 cows.

The proportion of calves in the Wager herd declined during both summers (Table 3). The 1976 cohort was estimated to make up 13% of the non-calf population as yearlings; however, the sample size was small (Table 3).

It appeared that the majority of this herd remained along the Wager Bay coast throughout both summers. As bulls drop their antlers shortly after the rut (Kelsall 1968), our observations of many cast antlers of mature bulls at the west end of Wager Bay suggests that caribou remain along the coast at least until after the rut in October.

3.3 Melville Herd

Our survey revealed that caribou were distributed across the breadth of Melville Peninsula south of 67°45' N. (Fig. 2). Although 2 to 3 weeks had passed since calving, bulls, yearlings, and non-productive cows were still sharply separated from the area containing cows and calves (Fig. 4). Bulls and young animals were distributed south of the calving grounds and closer to the coast, where the elevation was generally less than 300 m asl. The calving ground covered 11,000 km^2, most of which was above 300 m asl.

Sufficient effort was made to adequately delimit the calving ground and to calculate an estimate of calving ground population. Data on the distribution of other sex/age classes were not complete enough to attempt a direct estimate of the total population. The number of non-calf caribou on the calving ground was about 28,000 (Table 8). This estimate was quite precise with 95% confidence limits of only 15.8%.

To calculate the number of caribou in the total population we assumed, as we did in estimating the Lorillard herd, that the sex and age ratios on the Melville calving grounds were similar to those of the Kaminuriak herd. The resulting estimate of the total Melville population was 51,952 (27,924 x 0.8 ÷ 0.43).

In groups where calves could be accurately counted, the ratio was 62 calves:100 cows (702/1133). Within the calving area, caribou were fairly evenly dispersed with an average density of 2.0/km^2. The largest group we saw was estimated at only 85 animals and the average group size (including calves) was 5.5 (4442/803). Excluding calves, group size averaged 4.7.

No estimate of the June calf crop could be made since only a small proportion of the calves observed was enumerated. Few calves were recorded because caribou density was often too high to count both adults and calves, in which case only adults were tallied. This was less of a problem in surveys of the other herds, because densities there were much lower. Assuming calves made up about 30% of the herd at birth (Parker 1972), the proportion of calves declined during the summer as in the Wager herd (Table 3). Segregations in the fall indicated a high yearling count (18%) but the sample size was small (Table 3).

4. DISCUSSION

4.1 Population Status

The combined estimate of 81,000 caribou in the three tundra wintering herds described here accounts for approximately 15% of the barren-ground caribou in the Northwest Territories. Such large numbers were not anticipated because previous surveys had indicated only a few thousand animals on Melville Peninsula and a few hundred north of Wager Bay (Table 9). Either previous surveys missed the majority of the caribou, or else large numbers of caribou have immigrated from other areas. The former seems most likely. Earlier surveys covered only a small part of the ranges delimited in 1976 since they were hampered by poor visibility, navigational difficulties and relatively small budgets.

The 81,000 caribou in these three herds occupy about 170,000 km^2 of range and thus exhibit a population density of about 0.48 caribou/km^2; a density similar to many other caribou herds in North America (average = 0.51 caribou/km^2, Calef 1977).

The data on recruitment suggest that the Wager and especially the Melville herds are increasing. Bergerud (1978) has presented data showing that in several caribou herds, recruitment and adult mortality are related according to the equation, Y = 13.8 - 0.386X (where Y = adult mortality rate and X = recruitment rate as a per cent). Substituting the recruitment figures for the Wager herd (13%) and the Melville herd (18%) into Bergerud's equation results in adult mortality estimates of 8.8% and 6.9% respectively. Thus the annual finite rate of increase for the unhunted Wager herd is approximately (13% - 8.8% =) 4.2% and for the Melville herd is (18% - 6.9% - 1.4% * =) 9.7% (Table 10).

4.2 Herd Discreteness and Seasonal Distribution

Current terminology defines a caribou herd as a group of animals which consistently calve in a specific traditional location distinct from calving areas used by other herds (Skoog 1968, Thomas 1969). By this criterion, the three calving grounds located within the study area imply three separate herds.

Although the complete annual movement patterns of these herds are unknown, it is clear that these caribou spend the entire

* 1.4% = hunter kill

year on the tundra. The distance between Melville Peninsula and the nearest point at treeline is 1,000 km (Fig. 1) and no southern migration had begun by early September in 1976 or 1977. Observations of many cast antlers at the northwest end of Wager Bay indicate that this herd usually occupies the same range, after the rut in October. In addition, native people hunt caribou in these areas throughout the winter.

4.3 Life History Comparisons

Barren-ground caribou typically make long migrations twice a year between their winter range and their calving grounds and summer range. This contrasts with the relatively sedentary behaviour of the tundra wintering herds in northeastern Northwest Territories. We expected other behaviour changes associated with less extensive migration, and two were observed.

The most obvious difference was the absence of large post-calving aggregations in July in the Wager, Lorillard, and Melville herds. Migratory caribou usually form a few huge groups that include most of the herd. The only situation resembling a typical post-calving aggregation occurred in the Wager herd where we saw over 1,000 animals together in stratum 4 for a few days in late June.

Formation of large post-calving aggregations in barren-ground caribou has been suggested as a response to parasitic insects (Roby 1978), to predators (Bergerud 1974) and to the need for re-establishing "winter bands" broken during spring migration (Miller 1974). We feel that harrassment by mosquitoes is currently the best hypothesis for post-calving aggregations.

Mosquitoes emerged later (mid-July) on the northeastern mainland caribou ranges than on ranges of the Porcupine, Bathurst, Beverly, or Kaminuriak herds, which do form post-calving aggregations. Also, in the judgement of the senior author, mosquitoes were never as numerous at Wager Bay, or Melville Peninsula, as those he has experienced on the ranges of herds which do form post-calving aggregations. Similarly, on the arctic islands, where mosquitoes are rare or absent, Peary's caribou do not form post-calving aggregations. Roby (1978) found that group size of caribou in the Central Arctic herd correlated highly with mosquito activity, and Calef (unpublished) has observed the formation and breakup of the post-calving aggregations in the Porcupine herd to coincide closely with the beginning of mosquito activity and its decline respectively.

In herds which normally form post-calving aggregations, those few animals which do not join the aggregations frequently seek relief on patches of snow or aufeis (Roby 1978). In the Wager Bay and Melville Peninsula herds, the majority of the caribou employ this tactic for relief from mosquitoes, and on some days most snow patches harbour one or more caribou.

Little can be said about the predation hypothesis for post-calving aggregations in the northeastern mainland herds except to note that wolves were observed on the ranges of all herds during the summer. From prey remains at den sites, these wolves were known to have fed on caribou calves.

If Miller's (1974) socialization hypothesis is correct, then perhaps one could argue that the relatively sedentary tundra wintering caribou would have no need to re-establish social groups broken during a long spring migration. However, the Central Arctic herd in Alaska which is a comparatively sedentary tundra wintering herd does form post-calving aggregations. Moreover, Roby (pers. comm.) has pointed out another inconsistency in Miller's hypothesis. In the dispersal which follows the post-calving aggregations in many herds, the group size falls far below the size of the "winter band". Thus one must postulate another regrouping in these herds prior to winter.

The other difference between migratory and tundra wintering herds was summer group composition. We observed an unusually high proportion of cows, calves and yearlings. We were unable to quantify our results, partially because the identification of yearlings from the air is not always reliable. Nonetheless, it appeared to us that the cow/calf bond was not always broken before the birth of the next calf as is the rule for migratory caribou. Ten to 12 month old offspring are often left behind by their dams during the spring migration because of the females' stronger urge to migrate (Miller 1974). Where no major movement to a calving ground is required, "yearlings" can apparently physically keep up with their dams and are not repelled socially.

In most respects the tundra wintering herds were similar to migratory caribou. A significant similarity was the use, by all three herds, of a calving ground that was avoided by bulls and non-productive animals. Moreover, these calving grounds had the same high, rocky and relatively barren features as those of other herds (Kelsall 1968). Bergerud (1974) suggested that predation is often the selective force responsible for caribou's choice of calving sites. Wolf

predation on calves would likely be lowest on rocky calving grounds since, at this time of year, wolves select sandy habitats where it is easy to dig dens for their pups. Parker (1972) suggested that calves born in high rocky regions have a greater chance of avoiding death from exposure. These areas are drier than the lowlands since they have better drainage and if they receive precipitation, it is more likely to be snow than rain. The boulders and ridges provide more shelter even though the high country is generally windier.

As in the migratory populations, bulls and non-productive cows occupied greener pastures (usually coastal) during June, with cows joining them shortly after calving. Thus, it appears that calving grounds are selected for attributes which optimize neo-natal survival while summer range with high quality forage is selected to optimize growth.

Table 1. Calculation of the number of caribou 1 year of age and older in the Lorillard herd.

	Entire area surveyed	Calving ground only
Number of transects surveyed	21	13
Percent of area surveyed	10	10
Total area (km^2)	64,978	12,109
Observed density (caribou/km^2)	0.21	0.56
Population estimate	13,780	6,830
Population variance	11,269,125	-
Standard error	3,357	-
Half width of the 95% confidence interval on the population estimate as a per cent of this estimate	50.8	-
Population estimate corrected for observer bias	17,225	8,538

Table 2. The number and density of caribou in each age and sex class observed on the Lorillard calving ground.

	Age/sex class				
	Cows	Calves	Bulls	Unknown	Total
Number on the calving ground (12,000 km^2)	548	326	36	99	1009
Number not on the calving ground (53,000 km^2)	107	44	146	442	739
Total caribou observed	655	370	182	541	1748
Percent of age/ sex class on the calving ground	84	88	20	18	58
Density on the calving ground (caribou/km^2)	0.46	0.27	0.03	0.08	0.84

Table 3. Percentages of calves and yearlings in the three caribou herds in 1976 and 1977.

Herd	Calves in June	Calves 21 July	Calves 15 Aug.- 3 September	Yearlings 22 Aug.- 2 Sept.
Lorillard				
1976	21 (370/1748)[1]			
1977	30 (116/393)			
Wager				
1976	24 (1085/4446)		19 (162/854)	
1977	25 (201/812)	21(38/179)	21 (204/993)	13 (11/82)[2]
Melville				
1977		21 (61/285)	19 (253/1299)	18 (32/174)
Unweighted mean	25	21	20	16

[1] Sample size; number of calves/total population.

[2] Sample size; number of yearlings/population over 1 year of age.

Table 4. Calculation of the number of caribou 1 year of age and older in the Wager herd.

	Stratum				
	1	2	3	4	Total
Number of transects surveyed	7	7	8	-	22
Percent of stratum surveyed	5.0	9.3	15.7	100	-
Stratum area (km^2)	19,783	14,637	2,903	179	37,502
Observed density (caribou/km^2)	0.12	0.27	0.64	6.62	0.25
Population estimate	2,374	3,952	1,858	1,185	9,369
Population variance	414,736	313,494	402,944	0	1,131,174
Standard error	-	-	-	-	1,064
Half width of the 95% confidence interval on population estimate as a per cent of this estimate	-	-	-	-	23.6
Population estimate corrected for observer bias	2,967	4,940	2,323	1,381	11,711

Table 5. The density of calves in each stratum of the Wager study area.

Stratum	Calves/km^2	Number of calves per stratum
1	.03	565
2	.05	744
3	.16	455
4	2.72[1]	488

[1] Assuming a calf:cow ratio of 53:100 as estimated during the survey.

Table 6. Average group size in the Wager study area.

Stratum	1	2	3	Total area
Number of groups	25	53	31	109
Mean group size including calves	5.2	6.5	11.8	7.8
Standard error	1.8	0.7	2.0	1.4
Range	1-46	1-23	1-48	1-48
Mean group size excluding calves	4.2	5.5	9.5	6.3

Table 7. Calf to cow ratios in the Wager study area.

Stratum	Number of calves	Number of cows[1]	Calves per 100 cows
1	25	43	58
2	50	100	50
3	64	90	71
4	44	83	53
Total	183	316	58

[1] Estimated group sizes omitted from the analysis.

Table 8. Calculation of the number of caribou 1 year of age or older on the calving ground of the Melville herd.

Number of transects surveyed	33
Per cent of area surveyed	17
Calving ground area (km^2)	11,005
Observed density (caribou/km^2)	2.0
Population estimate	22,340
Population variance	3,240,000
Standard error	1,800
Half width of the 95% confidence interval on the population estimate as a per cent of this estimate	15.8
Population estimate corrected for observer bias	27,924

Table 9. Population estimates of the Melville and Wager herds before 1976.

Herd	Year	Estimated population	Source[1]
Melville	1972	2,200	Rippin and Bowden
Melville	1973	3,100	Pendergast and Bowden
Melville	1974	1,328	Bowden and Helmer
Wager	1974	200	Bowden and Helmer
Lorillard	never censused	-	-

[1] Unpublished Government of N.W.T. Wildlife Service reports

Table 10. Number of caribou reported killed by hunters from three communities on Melville Peninsula from 1966-1975.

Settlement	66/67	67/68	68/69	69/70	70/71	71/72	72/73	73/74	74/75	Weighted mean
Repulse Bay	254	302	273	281	554	450	549	-	-	380
Igloolik + Hall Beach	-	20	-	-	586	20	231	766	703	388
Total	254+	322	273+	281+	1,140	470	780	766+	703+	768

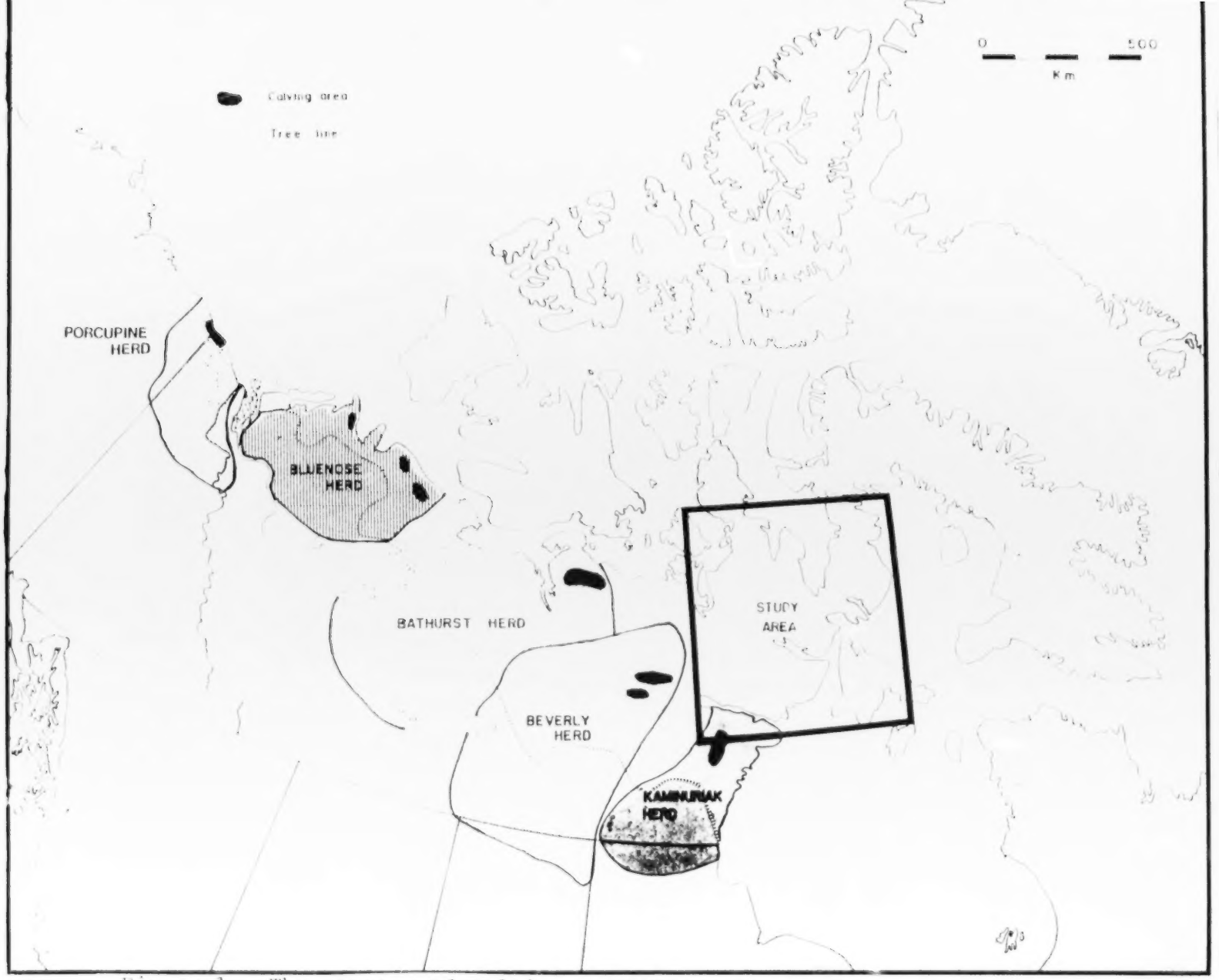
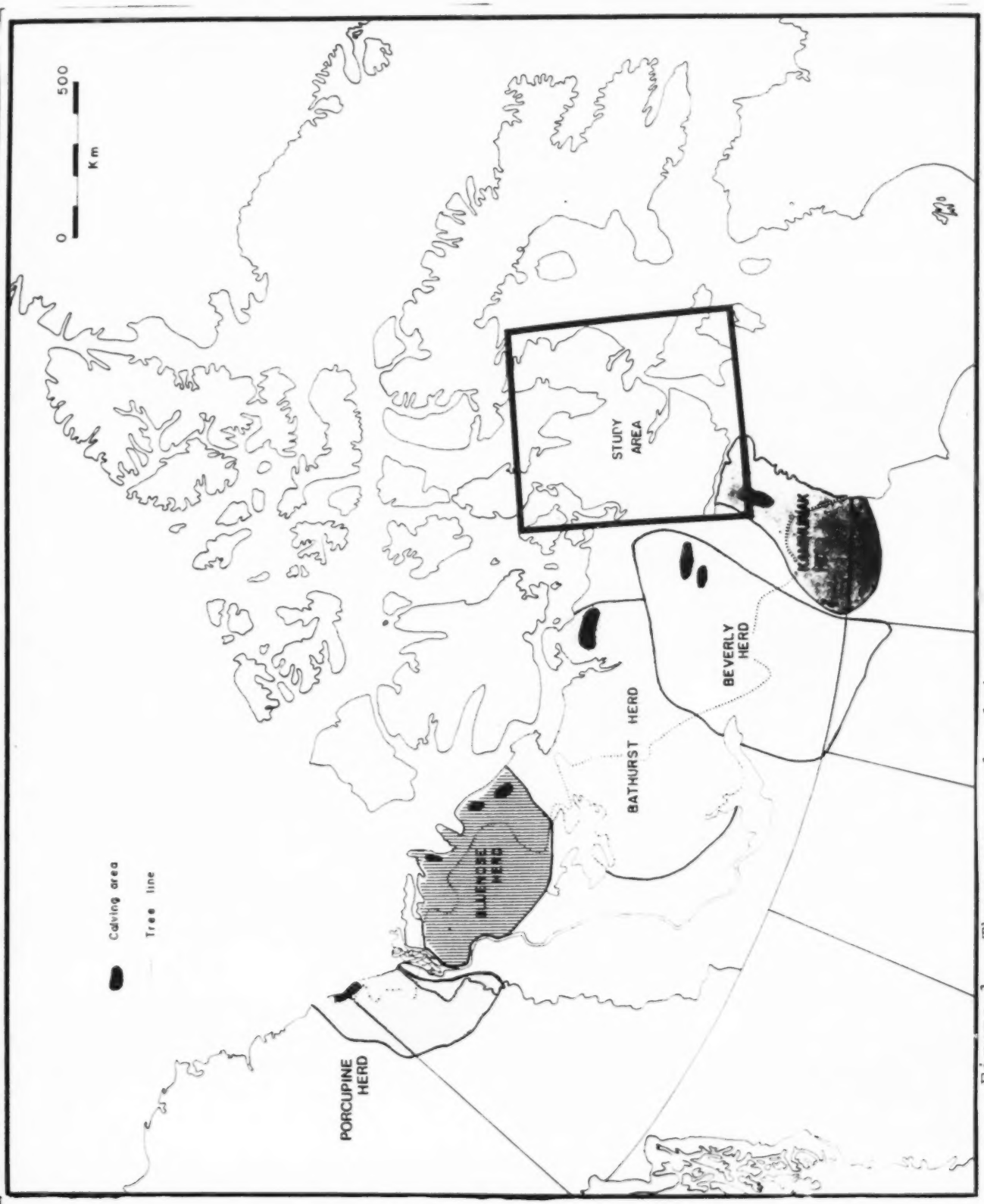


Figure 1. The ranges and calving grounds (black spots) of the five forest wintering barren-ground caribou herds in Canada



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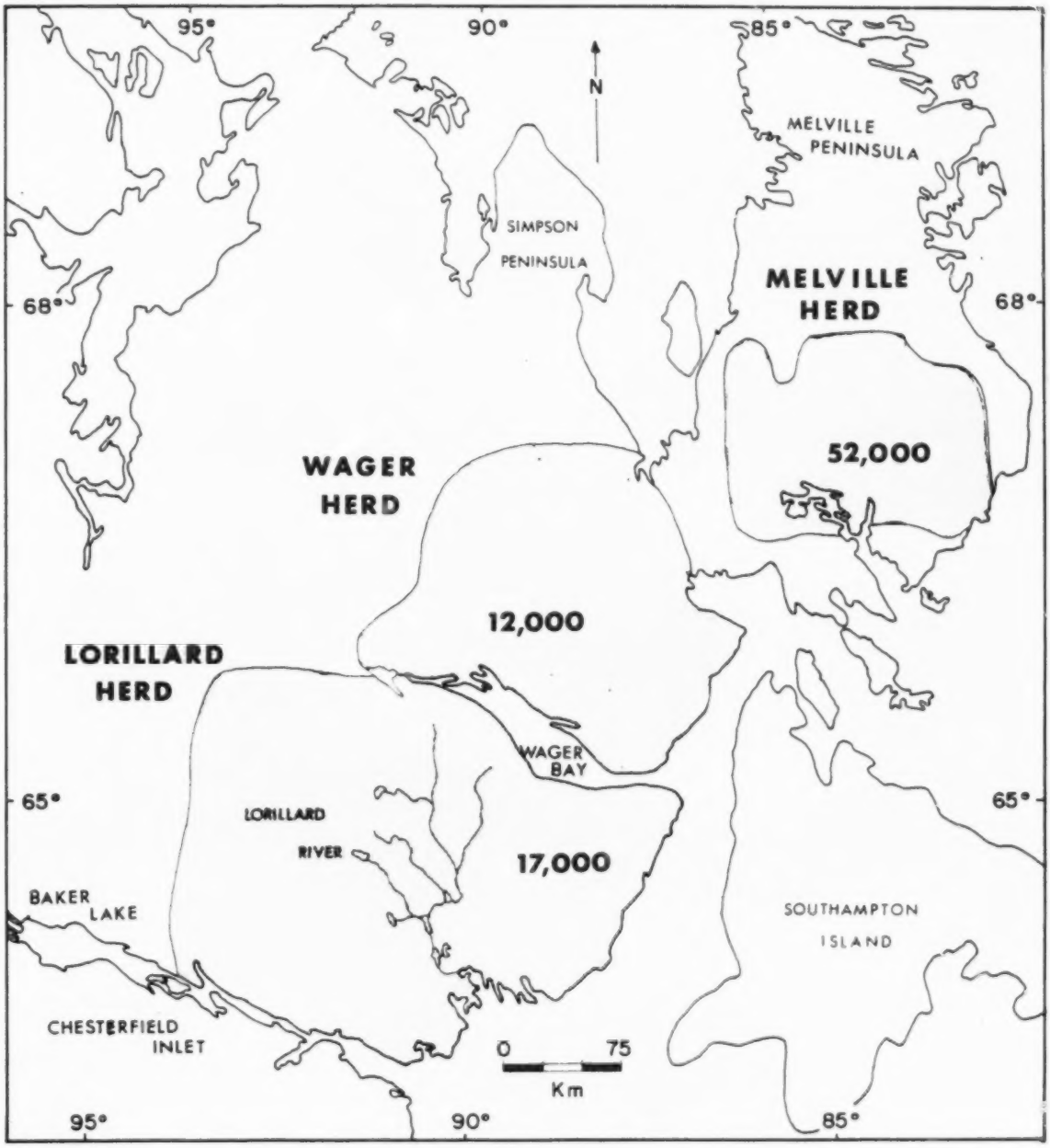

Figure 2. Distribution and population size of the Lorillard, Wager, Melville caribou herds.

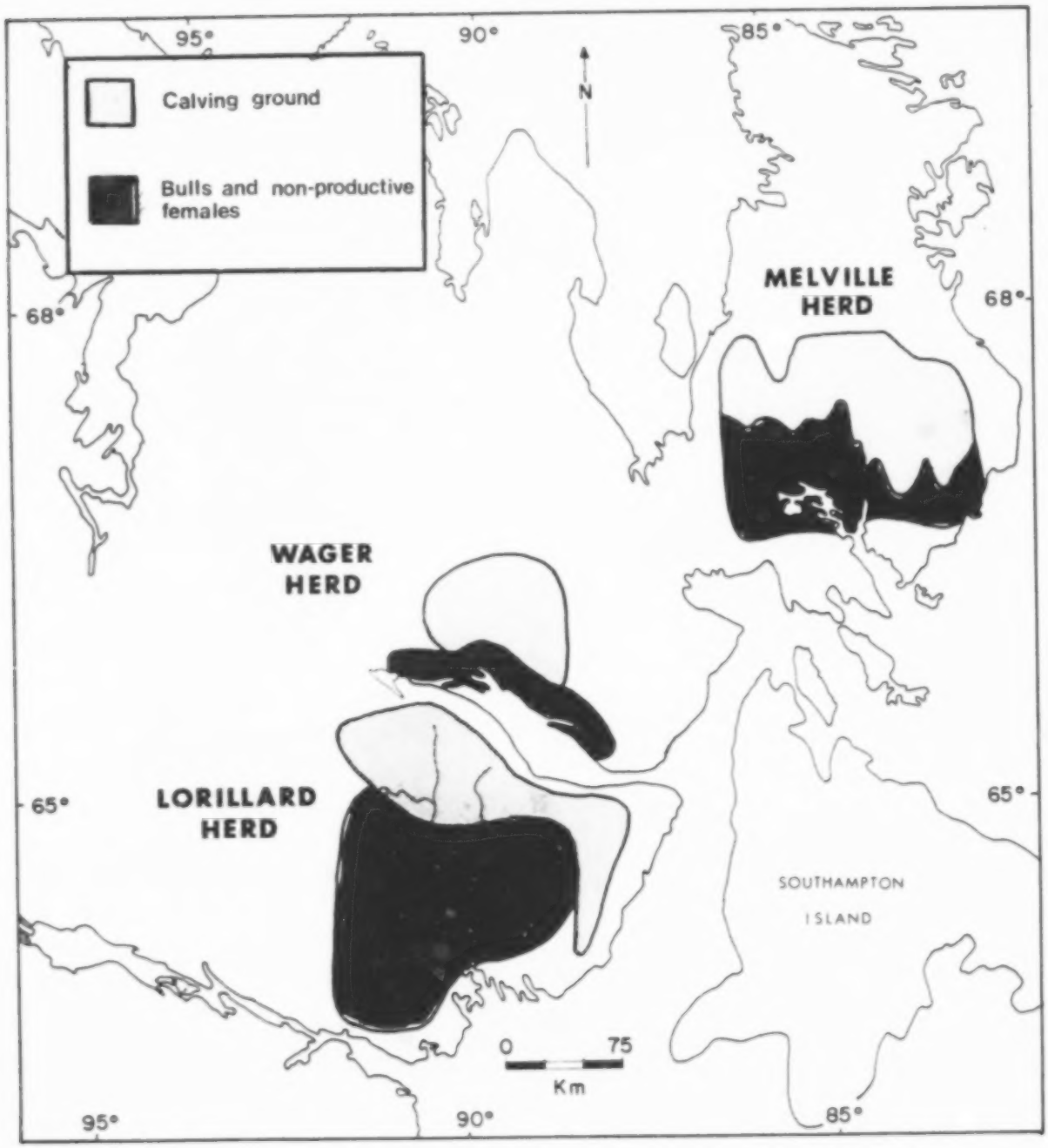

Figure 4. Calving ground locations and June distribution of bulls in the Lorillard, Wager and Melville caribou herds.

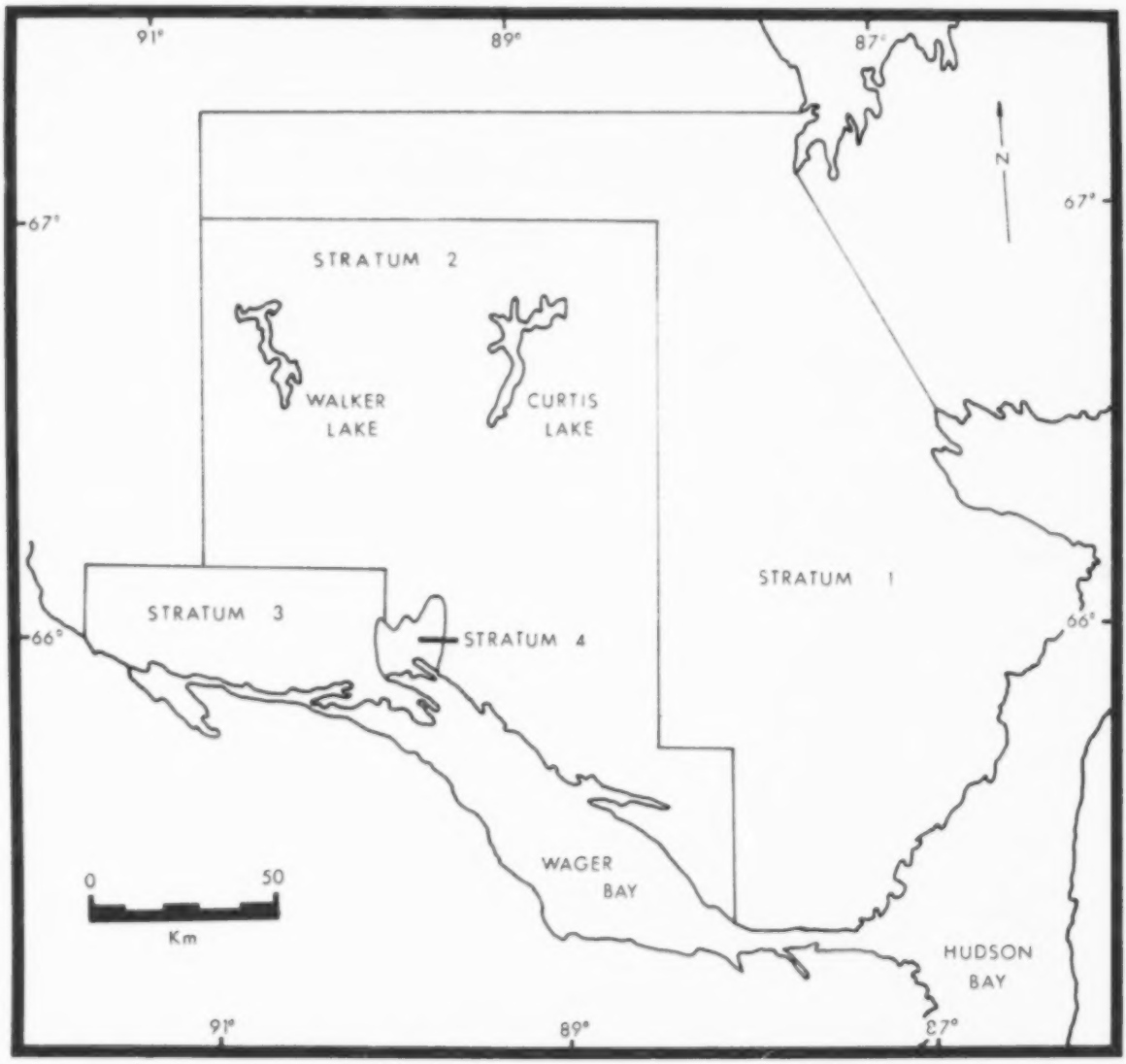

Figure 3. Location of the four strata surveyed to estimate the size of the Wager herd.

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